

## **The Impacts of Neutron Emissions on the Use of the National Ignition Facility (NIF)**

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The NIF is being designed to contain up to 1200 MJ of fusion yield per year, including up to fifty 20-MJ shots. This paper discusses the impacts on occupational safety and the shielding designs necessary to achieve the stated goals of neutron emissions while restricting exposures to less than 500 mrem per year for workers, to less than 50 mrem per year to personnel just outside the facility, and finally to less than 10 mrem per year to the public.

Neutron collimation, used to suppress unacceptable leakage of neutrons into the switchyard and laser bay, is described. Extensive use of aluminum in the Target Area supports relatively low levels of induced activity once the isotope  $^{24}\text{Na}$  (half life of 15 hours) has significantly decayed. The quantity of concrete shielding necessary to allow up to 50 shots of 20 MJ yield in a single year is presented based on a time and motion study where each major activity (target insertion, diagnostics maintenance, debris shield, etc.) is considered as to its time duration and proximity to activated structures, in order to limit the maximum dose to less than 500 mrem.

The use of boron in the Target Bay floors and chamber shielding is described, both its predicted effectiveness at suppressing  $^{24}\text{Na}$  and  $^{46}\text{Sc}$  production and, for the floors, its impact on the setting of 4000 psi concrete when added using boric acid. The dose rate that results from floor activation and chamber shielding is presented.

The capability for the NIF to generate neutrons will increase over time. It is predicted that several years will pass before a 20-MJ yield capability will be achieved. This impacts NIF design where certain features, such as thick shielding doors and the composition of near direct shine components such as the target positioner, diagnostic manipulators, and final optics assemblies, may be initially implemented made of one material (steel or aluminum) and then be replaced with another (carbon) to reduce activation levels sufficiently to allow fifty 20-MJ shots. This phased design approach to responding to the implementation of neutron emissions will be discussed. The need for in-chamber remote maintenance is discussed, both because of the induced  $^{24}\text{Na}$  activity, and the build-up over time of  $^{54}\text{Mn}$ . The ability to group yield shots together, perhaps a few per day of  $\sim 100$  kJ for a few days, and the ability to switch back and forth from significant yield experimental campaigns to no-yield campaigns where shot rates of four per day would be desired is also discussed.

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\*This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.